

## **Remarks**

Claims 1-6, 8, 12-16, 19-22 and 24-28 are pending.

Applicants thank the Examiner for withdrawing the previously outstanding rejections of claims 1-6, 8, 12-16 and 19-28 in view of the Muccini Declaration under 37 CFR §1.131 filed with the Amendment of August 13, 2010.

### **Summary of Telephonic Interview on July 1, 2011**

Applicants would like to thank the Examiner for conducting a telephonic interview to discuss the patent application with Applicants' Attorney Mark Polyakov on July 1, 2011. During the interview, all objections, rejections and art of record were discussed.

In particular, Applicants' Attorney and the Examiner discussed the rejections under 35 U.S.C. §102(b) over Bao (US 6,452,207) and the rejections under 35 U.S.C. §103(a) over Bao and Christensen (US 5,977,718).

### **Summary of Objections and Rejections**

The Office Action set forth the following objections and rejections:

claim 4 stands objected to due to an informality;

claim 8 stands rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention;

claims 1-3, 12, 15, 16, 22 and 24-28 stand rejected under 35 U.S.C. §102(a), as being anticipated by Bao (US 6,452,207) (from hereon, Bao);

claims 4-6 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Christensen (US 5,977,718) (from hereon, Christensen);

claim 8 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Marks (Europ. Pat. J., Vol. 32) (from hereon, Marks);

claims 13 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Brazis (US 2003/0122120) (from hereon, Brazis);

claims 19 and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Kozlov (US 6,160,828) (from hereon, Kozlov);

claims 1, 2, 4-6, 8, 21, 22, and 24-28 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov (J. Appl. Phys., Vol. 88) (from hereon, Necliudov) and in view of Marks;

claim 12 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 and in view of Rogers (Appl. Phys. Lett., Vol. 75) (from hereon, Rogers);

claims 13 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 and in view of Brazis;

claims 3, 15 and 16 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 and in view of Bao; and

claims 19 and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 and in view of Kozlov.

#### Claim Objection

Claim 4 stands objected to due to the phrase "the other one." Applicants have followed the Examiner's suggestion and amended claim 4 to replace this phrase with "another of the electron electrode and the hole electrode" for clarity.

Accordingly, the objection has been overcome and should be withdrawn.

### 35 U.S.C. §112(a) rejection

Claim 8 stands rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention due to the phrase "at least one material." Applicants have amended claim 8 to specify that the material is polycrystalline small molecule material.

Accordingly, the rejection has been overcome and should be withdrawn.

### 35 U.S.C. §102 rejections

#### Bao (US 6,452,207)

Claims 1-3, 12, 15, 16, 21, 22 and 24-28 stand rejected under 35 U.S.C. §102(a) as being anticipated by Bao. Applicants respectfully traverse the rejection.

Claim 1 requires the electroluminescence generating device to include, among other elements, a channel of a single polycrystalline small molecule material which is able to carry electrons and holes. Bao fails to teach or suggest this limitation. Specifically, Bao discloses a combination of two organic semiconductor materials: one of them is suitable for carrying p-type charges and the other is suitable for carrying n-type charges. Applicants respectfully refer the Examiner to the following statements in Bao:

-col. 6, lines 22-23: "The p-channel materials according to this invention are oligomers of fluorene."

-col. 7, lines 16-18: "All the fluorene containing oligomers perform as p-type transistors and are accumulation devices."

-col. 9, lines 64-66: "N-channel device materials, used in CMOS devices with the materials of the invention are conventional. Among these are..." (emphasis added).

Accordingly, it is clear from the specification that that fluorene oligomers disclosed in Bao are not capable of carrying both electrons and holes. While it may be

that the oligomers of Bao have useful emission properties, this is simply not relevant to the issue of whether or not these oligomers are ambipolar, i.e. capable of transporting charges of both electrons and holes. This is because emission properties are distinct from charge mobility properties. In other words, even if the oligomers of Bao have useful emission properties, they are still not ambipolar semiconductors capable of carrying charges of both types.

Therefore, Bao discloses devices comprising two layers of materials, each one being dedicated to carrying one type of charge. The device of the present invention is different in that it is based on a single ambipolar material which is capable of carrying charges of both types.

Dependent claims 2, 3, 12, 15, 16, 21, 22 and 24-28 incorporate all limitations of claim 1 and are therefore not anticipated by Bao.

For these reasons, Bao does not anticipate claims 1-3, 12, 15, 16, 21, 22 and 24-28. Accordingly, it is respectfully submitted that the rejection has been overcome and should be withdrawn.

### 35 U.S.C. §103(a) rejections

#### A. Rejections based on Bao (US 6,452,207)

##### Claims 4-6

Claims 4-6 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Christensen (US 5,977,718). Applicants respectfully traverse the rejection.

The Office Action admits that Bao does not teach that the electron electrode and hole electrode are formed of at least one different material. However, the Office Action states that Christensen teaches a device where the electron electrode and hole electrode are formed of at least one different material, and that it would have been obvious to form the electron electrode and hole electrode of Bao with the different materials taught by Christensen.

As Applicants have explained in the section of these Remarks dealing with the anticipation rejection of claims 1-3, 12, 15, 16, 21, 22 and 24-28 over Bao, Bao does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Bao or Christensen that would lead a person of ordinary skill in the art to replace the two layers of materials in the device of Bao with a single ambipolar polycrystalline small molecule material.

Accordingly, it is respectfully submitted that claims 4-6 are not obvious over Bao in view of Christensen for at least the same reasons that independent claim 1 is not obvious over Bao in view of Christensen and this rejection should be withdrawn.

#### Claim 8

Claim 8 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Marks (Europhys. Lett., Vol. 32). Applicants respectfully traverse the rejection.

The Office Action admits that Bao does not teach the use of sexithiophene in the device of claim 1. The Office Action states that Marks teaches using polycrystalline small molecule materials having a grain size, such as sexithiophene, as a single material electroluminescent layer, and that it would have been obvious to use this material with the device taught in Bao.

As Applicants have explained in the section of these Remarks dealing with the anticipation rejection of claims 1-3, 12, 15, 16, 21, 22 and 24-28 over Bao, Bao does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Bao or Marks that would lead a person of ordinary skill in the art to replace the two layers of materials in the device of Bao with a single ambipolar polycrystalline small molecule material.

Accordingly, it is respectfully submitted that claim 8 is not obvious over Bao in view of Marks at least because independent claim 1 is not obvious over Bao in view of Marks and this rejection should be withdrawn.

Claims 13 and 14

Claims 13 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Brazis (US 2003/0122120). Applicants respectfully traverse the rejection.

The Office Action admits that Bao does not teach the specific configuration for the electron and hole electrodes recited in claims 13 and 14. The Office Action states that Brazis teaches an organic semiconductor transistor with such a configuration, and that it would have been obvious to use the configuration set forth in Brazis for the electron and hole electrodes of Bao.

As Applicants have explained in the section of these Remarks dealing with the anticipation rejection of claims 1-3, 12, 15, 16, 21, 22 and 24-28 over Bao, Bao does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Bao or Brazis that would lead a person of ordinary skill in the art to replace the two layers of materials in the device of Bao with a single ambipolar polycrystalline small molecule material.

Accordingly, it is respectfully submitted that claims 13 and 14 are not obvious over Bao in view of Brazis at least because independent claim 1 is not obvious over Bao in view of Brazis and this rejection should be withdrawn.

Claims 19 and 20

Claims 19 and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Bao in view of Kozlov (US 6,160,828). Applicants respectfully traverse the rejection.

The Office Action admits that Bao does not teach the confinement optical resonators or cavities and waveguiding layers. The Office Action states that Kozlov teaches an organic light emitting laser using confinement optical resonators or cavities and waveguiding layers. The Office Action further states that it would have been

obvious to use the confinement optical resonators or cavities and waveguiding layers with the device of Bao.

As Applicants have explained in the section of these Remarks dealing with the anticipation rejection of claims 1-3, 12, 15, 16, 21, 22 and 24-28 over Bao, Bao does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Bao or Kozlov that would lead a person of ordinary skill in the art to replace the two layers of materials in the device of Bao with a single ambipolar polycrystalline small molecule material.

Accordingly, it is respectfully submitted that claims 19 and 20 are not obvious over Bao in view of Kozlov at least because independent claim 1 is not obvious over Bao in view of Kozlov and this rejection should be withdrawn.

#### B. Rejections based on Christensen (US 5,977,718)

##### Claims 1, 2, 4-6, 8, 21, 22 and 24-28

Claims 1, 2, 4-6, 8, 21, 22 and 24-28 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen (US 5,977,718) in view of Necliudov (J. Appl. Phys., Vol. 88) and in view of Marks (Europhys. Lett., Vol. 32). Applicants respectfully traverse the rejection.

Christensen teaches a gated pixel device employing a conjugated polymer electroluminescent material, where the gated pixel device is a triode or a diode. See, Abstract. Christensen does not teach or suggest that the conjugated polymer electroluminescent material is: a) polycrystalline and b) ambipolar, i.e. able to carry both electrons and holes. During the telephonic interview of July 1, 2011, the Examiner referred to col. 5, lines 20-30 in Christensen for support of the statement made in the Office Action on page 13 that Christensen discloses the channel being made of a single material capable of carrying electrons and holes. Applicants respectfully disagree.

The cited paragraph in Christensen discloses a diode comprising a MEH-PPV material as a LEP (light emitting polymer) material. In other words, the material is

described for its property of emitting light. However, there is nothing in Christensen that teaches that this material is capable of carrying both electrons and holes, as specified in claim 1 of the present application.

During the same telephonic interview, the Examiner also referred to col. 6, lines 20-35 of Christensen. The cited paragraph discloses a color display panel fabricated from an array of color pixel elements. The paragraph does not mention the MEH-PPV material, much less that it is capable of carrying both electrons and holes.

Applicants submit that, as of the time of the invention, the MEH-PPV material was not known to be a material capable of transporting charges of both types. To the contrary, this material was believed to be a p-type material (emphasis added). Applicants refer the Examiner to the scientific article by Lay-Lay Chua et al, *General observation of n-type field-effect behavior in organic semiconductors*, Nature, Vol. 434, pp. 194-199, March 10, 2005 submitted concurrently with this Amendment as Attachment 1. This article was published after the filing date of the present application. It proves that up to March 10, 2005, the MEH-PPV material was considered to be only a p-type material:

Organic semiconductors have been the subject of active research for over a decade now, with applications emerging in light-emitting displays and printable electronic circuits. One characteristic feature of these materials is the strong trapping of electrons but not holes<sup>1</sup>: organic field-effect transistors (FETs) typically show p-type, but not n-type, conduction..."

Chua et al, p. 194, introductory part.

The reference of Chua et al demonstrates that at the time of the invention there was a technical prejudice regarding the use of organic semiconductor materials as n-type transporting materials. In particular, the material cited by the Office Action, MEH-PPV, is cited in Chua et al in the table at page 196. Fluorene-based polymeric materials are also cited in the Chua et al article:

"The FET electron mobilities thus obtained reveal that the electrons are considerably more mobile in these materials than previously thought. Electron mobilities of the order of  $10^{-3}$  to  $10^{-2}$   $\text{cm}^2\text{V}^{-1}\text{s}^{-1}$  have been



measured in a number of polyfluorene copolymers and in a dialkyl-substituted poly(p-phenylenevinylene), all in the unaligned state.”

Chua et al, p. 194, introductory part.

The reference of Chua et al establishes that up to the date of publication of Chua et al in March 2005, there was a technical prejudice against the possibility of using organic semiconductor materials for manufacturing an ambipolar channel made of a single material layer.

The Office Action has not cited any document, published before the filing date of the present application, that discloses a device made with a channel which is capable of transporting both types of charge. There is nothing in Christensen, Necliudov or Marks that would teach or suggest the use of a channel which is capable of transporting both types of charge. Additionally, there is nothing in these cited references that discloses or suggests the use of a single thin layer of a single polycrystalline material capable of transporting both types of charge.

The Office Action admits that Christensen does not teach the use of a polycrystalline small molecule material having a grain size. However, the Office Action states that Marks teaches using polycrystalline small molecule materials having a grain size, such as sexithiophene, as a single material electroluminescent layer, and that it would have been obvious to use this material with the device taught in Christensen. Applicants disagree.

Marks discloses the use of an  $\alpha$ T6 material in a p-type device, i.e. an OFET which is capable of transporting only p-charges. There is nothing in Marks that would teach or suggest that the  $\alpha$ T6 material (or any other polycrystalline material) may be used to create a channel that transports both electrons and holes. At the time Marks was published, this material was known as a p-type semiconductor. It would not have been obvious that a p-type material known from Marks as a semiconductor material in a p-type diode structure, could be used for carrying a single-layer ambipolar channel. There is nothing in either of the cited references that would lead a person of ordinary skill in the art to the conclusion that the material used as a p-type semiconductor in Marks could be used as an ambipolar semiconductor. It is an impermissible hindsight to

find such use obvious, because until the present invention it was not known that such material could be used as an ambipolar semiconductor.

Likewise, there is nothing in Necliudov that would teach or suggest the use of a material capable of carrying both electrons and holes.

Dependent claims 2, 4-6, 8, 21, 22 and 24-28 are not obvious over Christensen in view of Necliudov and Marks for at least the same reasons that independent claim 1 is not obvious over these references.

For all of the above reasons, claims 1, 2, 4-6, 8, 21, 22 and 24-28 are not obvious over Christensen in view of Necliudov and Marks. Therefore, it is respectfully submitted that the rejection has been overcome and should be withdrawn.

#### Claim 12

Claim 12 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 above, and further in view of Rogers (Appl. Phys. Lett., Vol. 75). Applicants respectfully traverse the rejection.

The Office Action admits that Christensen does not teach the separation distance between the electron and hole electrodes. However, the Office Action states that Rogers teaches the separation distance between the electron and hole electrodes, and that it would have been obvious to set this separation distance between the electron and hole electrodes of Christensen.

As Applicants have explained in the section of these Remarks dealing with the obviousness rejection of claims 1, 2, 4-6, 8, 21, 22 and 24-28 over Christensen in view of Necliudov and Marks, Christensen does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Christensen, Necliudov, Marks or Rogers that would lead a person of ordinary skill in the art to use a single ambipolar polycrystalline small molecule material in the device of Christensen.

Accordingly, it is respectfully submitted that claim 12 is not obvious over Christensen in view of Necliudov and Marks as applied to claim 1, and further in view of Rogers, at least because independent claim 1 is not obvious over these references and this rejection should be withdrawn.

Claims 13 and 14

Claims 13 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 above, and further in view of Brazis (US 2003/0122120). Applicants respectfully traverse the rejection.

The Office Action admits that Christensen does not teach the specific configuration for the electron and hole electrodes recited in claims 13 and 14. However, the Office Action states that Brazis teaches an organic semiconductor transistor with such a configuration, and that it would have been obvious to use the configuration set forth in Brazis for the electron and hole electrodes of Christensen.

As Applicants have explained in the section of these Remarks dealing with the obviousness rejection of claims 1, 2, 4-6, 8, 21, 22 and 24-28 over Christensen in view of Necliudov and Marks, Christensen does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Christensen, Necliudov, Marks or Brazis that would lead a person of ordinary skill in the art to use a single ambipolar polycrystalline small molecule material in the device of Christensen.

Accordingly, it is respectfully suggested that claims 13 and 14 are not obvious over Christensen in view of Necliudov and Marks as applied to claim 1, and further in view of Brazis, at least because independent claim 1 is not obvious over these references and this rejection should be withdrawn.

Claims 3, 15 and 16

Claims 3, 15 and 16 stand rejected under 35 U.S.C. §103(a) as being

unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1 above, and further in view of Bao (US 6,452,207). Applicants respectfully traverse the rejection.

With respect to claim 3, the Office Action admits that Christensen does not teach the material of a dielectric layer between the control electrode and the channel. However, the Office Action states that Bao teaches using silicon oxide or polyimide as the dielectric material, and that it would have been obvious to use the dielectric material taught in Bao in the device of Christensen.

With respect to claims 15 and 16, the Office Action admits that Christensen does not teach that the control electrode is positioned on the second side of the channel. However, the Office Action states that Bao teaches that the control electrode is positioned on the second side of the channel, and that it would have been obvious to position the control electrode on the second side of the channel in the device of Christensen.

As Applicants have explained in the section of these Remarks dealing with the obviousness rejection of claims 1, 2, 4-6, 8, 21, 22 and 24-28 over Christensen in view of Necliudov and Marks, Christensen does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Christensen, Necliudov, Marks or Bao that would lead a person of ordinary skill in the art to use a single ambipolar polycrystalline small molecule material in the device of Christensen.

Accordingly, it is respectfully suggested that claims 3, 15 and 16 are not obvious over Christensen in view of Necliudov and Marks as applied to claim 1, and further in view of Bao, at least because independent claim 1 is not obvious over these references and this rejection should be withdrawn.

### Claims 19 and 20

Claims 19 and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Christensen in view of Necliudov, in view of Marks as applied to claim 1, and further in view of Kozlov (US 6,160,828). Applicants respectfully traverse the rejection.

The Office Action admits that Christensen in view of Necliudov and Marks does not teach the confinement optical resonators or cavities and waveguiding layers. However, the Office Action states that Kozlov teaches an organic light emitting laser using confinement optical resonators or cavities and waveguiding layers. The Office Action further states that it would have been obvious to use the confinement optical resonators or cavities and waveguiding layers with the device of Christensen in view of Necliudov and Marks.

As Applicants have explained in the section of these Remarks dealing with the obviousness rejection of claims 1, 2, 4-6, 8, 21, 22 and 24-28 over Christensen in view of Necliudov and Marks, Christensen does not disclose or suggest an electroluminescence generating device which includes a channel of a single polycrystalline small molecule material which is able to carry both electrons and holes. There is nothing in either Christensen, Necliudov, Marks or Kozlov that would lead a person of ordinary skill in the art to use a single ambipolar polycrystalline small molecule material in the device of Christensen.

Accordingly, it is respectfully suggested that claims 19 and 20 are not obvious over Christensen in view of Necliudov and Marks as applied to claim 1, and further in view of Kozlov, at least because independent claim 1 is not obvious over these references and this rejection should be withdrawn.

### Conclusion

Applicants respectfully submit that the application is in condition for allowance. Accordingly, a Notice of Allowance is believed in order and is respectfully requested. If the Examiner has any questions concerning the above, the Examiner is respectfully requested to contact the undersigned at the telephone number listed below.

If any additional fees are incurred as a result of the filing of this paper, authorization is given to charge Deposit Account No. 23-0785.

Respectfully submitted,

/Mark Polyakov/

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